How do I calculate steam turbine efficiency?

6 Answers

Sreedhar Murthy, Behavior Analyst.
Answered Mar 30, 2017

To calculate use this method.

Calculation Details

Step 1: Determine Inlet Properties

Using the Steam Property Calculator, properties are determined using Inlet Pressure and the selected second parameter (Temperature, Specific Enthalpy, Specific Entropy, or Quality). The Specific Enthalpy is then multiplied by the Mass Flow to get the Energy Flow:

- Inlet Energy Flow = Specific Enthalpy * Mass Flow

Step 2: Calculate Ideal Outlet Properties (Inlet Entropy equals Outlet Entropy)

Step 3: If solve for 'Isentropic Efficiency', Determine Outlet Properties

Using the outlet specific enthalpy, calculate the isentropic efficiency:

- Isentropic Efficiency = (Inlet Specific Enthalpy - Outlet Specific Enthalpy) / (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy)

Step 3: If solve for 'Outlet Properties', Determine Outlet Specific Enthalpy

1. Isentropic Efficiency = (Inlet Specific Enthalpy - Outlet Specific Enthalpy) / (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy)
2. Isentropic Efficiency * (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy) = (Inlet Specific Enthalpy - Outlet Specific Enthalpy)
3. Outlet Specific Enthalpy = Inlet Specific Enthalpy - Isentropic Efficiency * (Inlet Specific Enthalpy - IDEAL Outlet Specific Enthalpy)

Using the outlet specific enthalpy, calculate the outlet properties:

Step 4: Calculate Steam Turbine Energy Out and Generation (Power Out)

- Energy Out = (Inlet Specific Enthalpy - Outlet Specific Enthalpy) * Mass Flow
- Power Out = Energy Out * Generator Efficiency

Assumptions

- Inlet Mass Flows equal Outlet Mass Flow.

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Shubhank Tekam, studied Mechanical Engineering at Jabalpur Engineering College (2018)
Answered Apr 11, 2017

Since the turbine is power generating device which abstract energy from working fluid ..

Firstly To find out efficinecy of steam turbine ,we will have to find out how much input is given to turbine unit and how much shaft work or output power we r obtaining in response to that particular input value from particular design of steam turbine . Along with these data we can easily find out effecincy of turbine .effeciency of m/c is given by mathematically

Efficinecy = output power that produce turbine /input power given to turbine unit

From above mathematical equation if input/output gives value = 1 that mean input power given to turbine unit must be equal to power generated by turbine that mean all the power that given to turbine is completely converted into shaft power without any losses of energy . but practically this is not possible yet some losses will be associated with turbine unit during operation such as frictional losses due to roughness of vane surface , always output power value will be obtained lesser than input power given to turbine unit . In the case of steam turbines following factors decides the overall efficiency f the turbine.

- Velocity of input steam (which in turn depends on the temperature and pressure of steam)
- Angle of guiding vanes
- Blade angle on the rotor
- Radius of rotor

There are two **types of steam turbine** impulse turbine and reaction turbine. Both types of steam turbines have different efficiency due to their different working principles but the efficiency of both types of steam turbines is expressed by the following equation.

Efficiency = Work Done / Input Kinetic Energy

Here input kinetic energy totally depends on the absolute velocity of the steam at the inlet of steam turbine but work done depends on lots of factors including drop in heat content of steam within the turbine, the angle of guide vanes especially at the inlet of turbines, blade angles, relative velocity of steam in the turbine, etc. It is fairly difficult to calculate work done by turbine because of all these factors and in some cases it is not possible to accurately calculate certain factors like velocity, temperature, or pressure of steam. There are two ways of calculating steam efficiency. These methods referred as blade efficiency and stage efficiency . Blade efficiency is calculated using the velocity of the steam while stage efficiency is calculated by measuring changes in the enthalpy of the steam. Enthalpy is referred to

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the heat content of the steam. In both cases the angle of guide vanes at the inlet plays an important role which is represented by a1(alpha1) . The cosine of this angle plays the central role in defining the efficiency of both impulse and reaction steam turbine . by plotting velocity triangle we can find out work done . simply

Turbine efficiency = work done by trbine / kinetic energy of steam .

For deeper info open turbo machine book and clear necessary concept related to steam turbine ..above was just intro fr calculation of efficiency of steam turbine ..

☺

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Dabbiru Dheeraj, BTech Mechanical Engineering, MVGR College of Engineering (2019)
Answered Nov 13, 2017

generally, for any body the efficiency will be the ratio of work output to the input heat.In case of turbines, the nozzles are used to inject steam on to the turbine blades with high velocities. so, the input energy to the turbine will be the kinetic energy due to the nozzles.

steam turbines are mostly classified into impulse and reaction turbine. the efficiency formula varies from impulse to reaction. this efficiency also depends upon the number of blade stages in a turbine.

efficiency for a single row impulse turbine is explained below,

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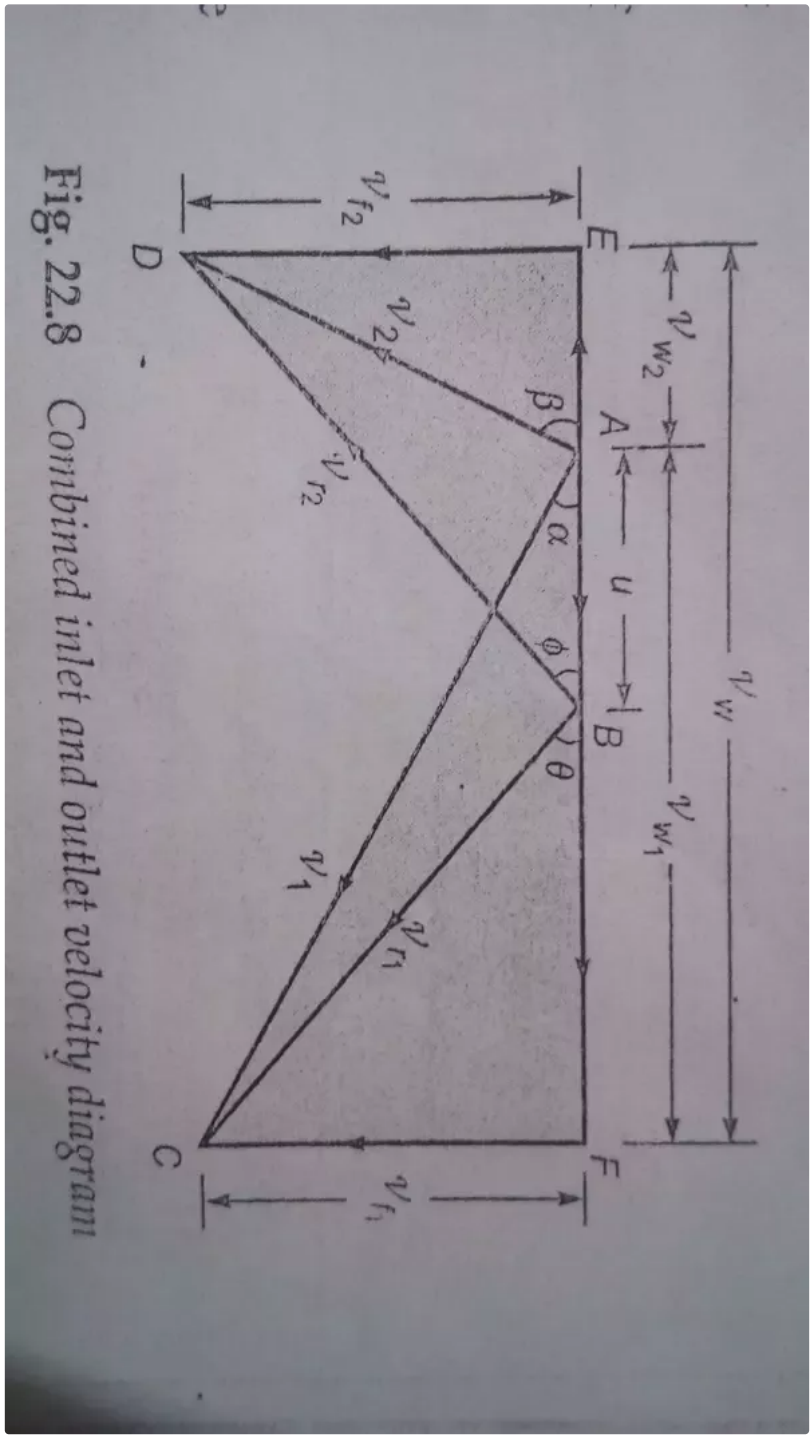

The above picture is the velocity profile at inlet and outlet of the blade.

We know that,

force = rate of change in momentum

I.e F= m.(dV) (here, m= mass/sec)

The whirl velocities are responsible for the rotation of the blades or to produce work.

Hence , F= m.((Vw1)-(-Vw2))

[Vw1 is opp in direction to Vw2]

F= m.(Vw1+Vw2)

Workdone will be W= F.u

(here, u is the blade velocity)

Then , W= m.(Vw1+Vw2).u

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This is the work done by the blade.

Therefore, the efficiency will be ratio of work done by the blade to the input energy

Efficiency= W/KE

I.e m.(Vw1+Vw2).u/ (0.5 mV1^2)

(masses are canceled)

=> 2(Vw).u/V1^2. (here Vw1+Vw2=Vw, and V1 is the velocity at the entrance)

Hence, efficiency for a single row impulse turbine is derived.

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Nurul Hossain, worked at Former Dept Chair - Mechanical Eng, York Technical College
Answered Dec 8, 2017

First thing you need to know is “What type of steam turbine are you talking about?” Then depending on the type of steam turbine you have, look into a engineering thermodynamics level I and II books, and pick up the right equation for efficiency calculations.

Need to take into consideration the type of superheat used, or type of co-generation used. Quora is not the forum to discuss all the details of steam turbine efficiency.

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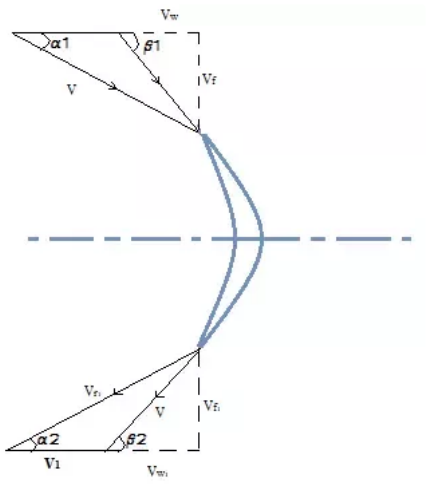
Nishu Yadav, Mechanical engineer
Answered Jan 25, 2016



- Here :-

Alpha (a) = Nozzle angle or guide vane angle.

V 1=absolute velocity at inlet

V 2= absolute velocity at exit.

Vf= flow velocity

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Vw= whirl velocity

m(mass flow rate) =

q.a.Vr1

Here - a=area

q=row, density

Vr1= relative velocity.

- In x-direction

Fx=m.V1.cos(a)-(-m.V2.cos(b))

=m(V1cos(a)+V2cos(b))

Here.

V1cosa=vw1

V2cosb=vw2

- Now

Fx=m(Vw1+Vw2)

Work done /sec =m(Vw1+Vw2)u1

Efficiency (n)=work done per sec /w.p

=m(Vw1+Vw2)u1*100 /.5m(Nozzle). Vi^2

- In y-direction

Fy=m(vf1-Vf2)

Thanks

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Hemanth Morupakala, studies Mechanical Engineering at Gudlavalleru Engineering College (2019)
Answered 2h ago

actual expansion by theoretical expansion

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